Marine Corps Science and Technology Strategic Plan

MARINE CORPS SCIENCE AND TECHNOLOGY STRATEGIC PLAN

Sep 2005

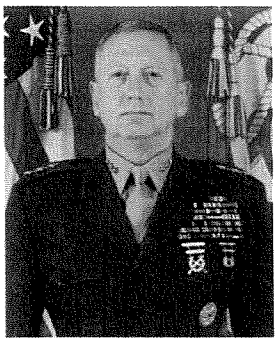
The *Marine Corps Science and Technology Strategic Plan* establishes the priorities and direction for science and technology investment in the technologies that we need for our future Marine Corps. As you read this Plan, you will find that it addresses capability needs for all the elements of our Marine Air-Ground Task Force.

This Plan is designed to complement the *Marine Corps Expeditionary Maneuver Warfare Capability List* by identifying as science and technology objectives – STOs -- the technology enhancements most needed to enable the warfighting capabilities of our future Marine operating forces. The STOs are not intended to be all-inclusive. Instead, they identify the priority S&T objectives needed to implement our vision for the 21st century Marine Corps.

This Plan is intentionally designed to mirror the warfighting functions contained in the *Expeditionary Maneuver Warfare Capability List* so as to clearly depict the linkages between our capability needs and those science and technology pursuits that we have determined to be essential. However, we have added separate sections for Mine Counter Measures and Human Performance and Training in recognition of the specific science and technology investment made in these critical enabling combat development areas.

In addition, we have included Annexes that address the capability needs we wish to emphasize to the Navy for naval science and technology investment on behalf of a future seabased, power projection Navy-Marine Corps team capable of implementing distributed operations and increasing our agility and speed in operations from cooperative security to major combat.

We must not forget that it is the infantryman who is the centerpiece of our institution, even though expertly supported by combat power of immense lethality from the air-ground team and superbly sustained by Marine logistics. Accordingly, you will note that this plan focuses on S&T capabilities that enhanced small units that are more autonomous, more lethal, and better able to operate across the full spectrum of operations. This will require investment in the technologies that will provide individual communications, tactical mobility, and networked intelligence down to the squad level.



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Deputy Commandant for Combat Development and Integration

Marine Corps Science and Technology Strategic Plan

Ref: (a) MCO 3900.15B
(b) Expeditionary Maneuver Warfare Capability List

Annexes: (A) N6/7 Warfighting Gaps
(B) Future Naval Capabilities
(C) Aviation Science & Technology Objectives

1. **Purpose**. To provide a strategic plan for the Marine Corps Science and Technology (S&T) enterprise. The Plan focuses Marine Corps S&T efforts to pursue S&T initiatives and support experimentation of concept-based requirements to achieve future Marine Corps capabilities.

2. **Background**

a. Technological superiority continues to be a cornerstone of the National Military Strategy**.** Maintaining this technological edge is important as high technology weapons become readily available on the world market. It is imperative that the Marine Corps possess technological superiority to implement Expeditionary Maneuver Warfare (EMW) to enhance its future warfighting capabilities to counter traditional, irregular, catastrophic, and disruptive events.

b. The Marine Corps maintains a focused S&T effort to assess and develop those technologies that enhance Marine Operating Forces' warfighting capabilities and to prosecute an effective warfighting experimentation program.

c. *Marine Corps Strategy 21* defines the Marine Corps contribution to the joint capabilities. EMW is the capstone concept for the early 21st century, which is built on core competencies and refines the broad axis of advances identified in *Marine Corps Strategy 21*. EMW links Marine Corps concepts with joint concepts to meet the challenges and opportunities of a rapidly changing world in support of Combatant Commanders.

3. **General**

a. The Marine Corps S&T Enterprise is an integral part of the larger Naval Research Enterprise (NRE). It is a collaborative effort between the Marine Corps Combat Development Command (MCCDC), the Marine Corps Systems Command (MCSC), and the Office of Naval Research (ONR). This relationship is depicted in Figure 1.

b. The Commandant of the Marine Corps provides the future vision for the Marine Corps based on strategic guidance. The Deputy Commandant for Combat Development and Integration (DC, CD) expands on CMC's vision by developing Marine Corps warfighting concepts and determining required capabilities in Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities to enable the Marine Corps to field combat-ready forces.

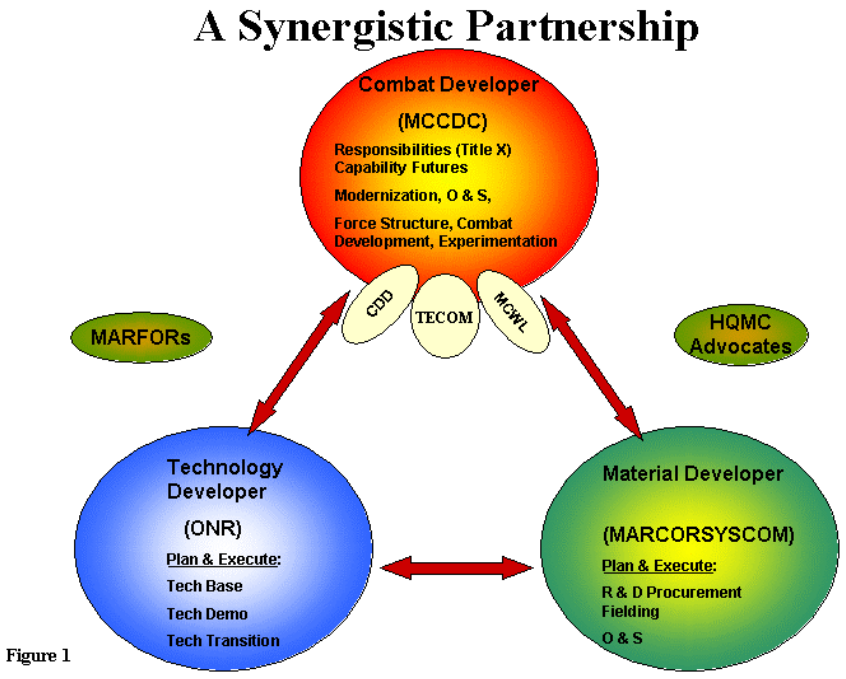

Figure 1

c. The Marine Corps Combat Development Command serves as the combat developer for the Marine Corps in the same way that the Marine Corps Systems Command serves as the materiel developer and the Office of Naval Research is technology developer for the Department of the Navy (Navy and Marine Corps). Coalescing these responsibilities requires a synergistic partnership with a common vision, a strategy, and an implementing plan.

d. The Marine Corps Warfighting Lab supports combat development as a subordinate command of MCCDC. The Marine Corps Warfighting Lab develops the family of concepts that help articulate the future vision of the Marine Corps. Additionally, it conducts operational experiments that support emerging concepts, develops selected technologies, and explores improvements in tactics, techniques, and procedures (TTP).

e. The Marine Corps S&T strategy is derived from gap analyses in an effort to develop and focus on S&T objectives, as well as, programs that manage the Marine Corps allocation of naval S&T resources. In addition the Marine Corps leverages the investment of ONR, the NRE, Defense Advanced Research Projects Agency (DARPA), other Services, and industry while focusing our Marine Corps unique investment to ensure Marine Corps combat development and future materiel needs. This approach must ensure that we are meeting our near-term needs – primarily those of the current operating forces; our mid-range needs – primarily those of the materiel developer in technology enhancements to acquisition programs for the next Marine Corps; and the far-term needs of the Marine Corps after next as articulated in our future concepts by the combat developer in support of *Naval Transformation.*

f. The current Department of the Navy strategic planning context for the Marine Corps S&T Strategic Plan is shown in Figure 2:

Figure 2

4. **Capability Needs**

a. The Marine Corps capability needs are determined as a result of reference (a) and are articulated principally through the Expeditionary Maneuver Warfare Capability List (ECL) reference (b), and as contained in Universal Needs Statements (UNS), Initial Capability Documents, Capability Development Documents, and Capability Production Documents. In addition, Marine Corps S&T capability needs are influenced by the Advocates Requirements List (ARL) and supporting S&T addendums to the ARL.

b. The determination of Marine Corps S&T capability needs is integrated with the OPNAV N6/7 gap analysis process. OPNAV N-6/7 has established an operational gap analysis process that is integrated with the ONR's Future Naval Capability (FNC) program. The goal of the integration process is to ensure that at least a portion of the S&T projects ongoing at ONR (the FNC program) are in support of capability gaps that are established by OPNAV N6/7. The OPNAV N6/7 gap analysis process consists of wargaming multiple scenarios, developing Mission Capability Packages (MCPs), and then defining the capability gaps within each MCP.

c. The Marine Corps conducts a Marine Corps focused S&T gap analysis prior to participation in the N6/N7 gap analysis process. This gap analysis prioritizes capability needs from the Marine Corps Advocates and serves as a key reference for developing Marine Corps S&T objectives (STO). Representatives then participate in the OPNAV N6/N7 gap analysis process to develop Naval S&T gaps. Marine Corps representatives will use the ECL during both the Marine Corps S&T gap analysis and OPNAV N6/N7 gap analysis.

d. In order to ensure that Marine Corps capability gaps come under consideration during the OPNAV N6/7 gap analysis process, the Marine Corps participates in the OPNAV N6/7 gap analysis process. Marine Corps representatives in the OPNAV N6/7 gap analysis process will

use the ECL to identify our Service-specific capability gaps. The current N6/7 warfighting gaps are listed in Annex A.

5. **Assumptions**

a. The Marine Corps-unique expeditionary maneuver warfare capabilities and naval character remain relevant and essential.
b. The Marine Corps core competencies as contained in *Marine Corps Strategy 21* and EMW remain unchanged.
c. S&T resources available to the Marine Corps remain constrained but the goal is 3% real program growth as established by the *Strategic Planning Guidance*: "Components will maintain or increase S&T investment at the levels programmed in the FY2005-2009 President's Budget FYDP for FY 2006-FY2009 with the goal of achieving 3% annual real growth."
d. Marine Corps warfighting functions will remain unchanged.
e. Emerging concepts in support of Distributed Operations, Urban Operations, Irregular Warfare, or Fourth Generation (asymmetric) Warfare will be addressed by S&T in the mid- and long-range planning process.

6. **S&T Budget Categories**

a. The Department of Defense delineates budget activities with specific funding categories for science and technology known as: basic research, applied research, and advanced technology development.

(1) **Basic Research (6.1)** includes scientific study and research to increase knowledge and understanding in the physical, engineering, environmental and life sciences related to long-term naval needs. Its focus is knowledge of scientific phenomena. Discovery and invention is the responsibility of ONR and current research areas of primary interest to the Marine Corps are:

- Autonomous Systems
- Communications
- Lightweight Power Sources
- Information Efficiency
- Sensing
- Human Performance
- Landmine and Improvised Explosive Device (IED) countermeasures (to include both detection, induced pre-detonation, and survivability)
- Energetic Materials
- Urban/Asymmetric Warfare
- Small Unit Excellence

(2) **Applied Research (6.2)** is the systematic study to understand the means to meet recognized and specific naval needs. Applied research translates promising basic research into solutions for broadly defined military needs, short of system development projects. Its focus is proving technology feasibility when applied to solving military problems.

(3) **Advanced Technology Development (6.3)** includes the development of subsystems and components and the efforts to integrate subsystems and components into system prototypes for field experiments and/or tests in a simulated environment. The focus is on demonstrating the military utility of technologies and applying them to acquisition programs. It supports the Future Naval Capabilities (FNC) program as shown in Annex B and warfighting experimentation conducted by the Marine Corps Warfighting Laboratory.

7. **Science & Technology Objectives**

a. STOs* are established to provide combat development guidance to the S&T community, primarily the NRE but also other Services, defense agencies, industry, and academia. A STO states a major technological advancement to be achieved and is in support of a capability need identified and prioritized during S&T gap analysis. STOs must be consistent with the funding available in the Future–Years Defense Plan. The Marine Corps S&T budget submission is developed to support this Marine Corps Strategic Plan.

b. The STOs are also the principal driver for Navy S&T investment in the Land Warfare component of Naval expeditionary warfare.

c. Expenditures for Aviation STOs are Navy "blue" dollars and are addressed through a separate mechanism. However, aviation is an inherent part of the Marine Corps approach to combat development across all warfighting functions. Accordingly, aviation STOs are both embedded in the warfighting functions and broken out separately in Annex C. The purpose of Annex C is to document the S&T priorities of the Deputy Commandant, Aviation for use by Marine Corps S&T Integrated Product Team (IPT) and in N6/7 gap analysis.

d. The Marine Corps S&T Strategic Plan attempts to mirror the six-warfighting functions provided by the framework contained in the ECL, reference (b). Warfighting functions assist commanders in achieving unity of effort to build and sustain combat power when used in concert with another and should not be viewed independently but as inseparable parts of a whole. Each warfighting function was designed to depict the linkage of the general statement, vision, and goal to the individual STOs. Mine Countermeasures and Human Performance Training and Education are two additional functions that have been broken-out separately due to their importance and distinction. Therefore, the sequence of the warfighting functions is as follows: Command and Control, Maneuver, Logistics, Fires, Intelligence, Force Protection, Mine Countermeasures, and Human Performance Training and Education.

Command and Control

The S&T investment in Command and Control is focused in three main areas: (1) implementing the FORCEnet concept with technologies to distribute data, (2) developing decision support systems that enable warfighters to take advantage of the FORCEnet shared situational awareness, and (3) providing effective combat identification of enemy combatants, friendly forces, and non-combatants.

* Army Technical Objectives are similar in purpose to Science and Technology Objectives

<u>The Vision</u>: Through a seamless information architecture, future comprehensive command and coordination will be characterized by increased freedom of action and enhanced access to all elements of national power through comprehensive interconnected networks.[1]
<u>Goal</u>: The focus is directly associated with the Naval Concept of FORCEnet and MAGTF C2. Integration of all force elements throughout the battlespace, including: satellites, manned aircraft, ships, submarines, Unmanned Combat Vehicles, Unmanned Ground Vehicles, Unmanned Aerial Vehicles[2]*, Unmanned Underwater Vehicles, unattended space, air, ground and sea sensors and warfighters afloat and ashore*[3]*. Forces, activities and platforms are interconnected in this networked, collaborative command and control environment, thereby benefiting from the advantages of decentralization—initiative, adaptability, and increased tempo—without sacrificing the coordination or unity of effort typically associated with centralization. The system will provide a shared understanding of position location information on friendly forces and will incorporate combat identification technology to facilitate distinguishing combatant forces. Commanders will be able to gain and maintain situational awareness, make better decisions, and exercise authority and direction over assigned forces via an adaptable, distributive, and seamless system.*[4]

-- C2 STO-1: Digital networks with assured, secure communications linking all echelons of the MAGTF

Develop network centric warfare technologies that enable early entry forces to communicate over the horizon and on the move (OTH/OTM)[5] with each other, and interoperate with other naval and joint forces in order to leverage joint fires and logistics on the future battlefield.

-- C2 STO-2: Multilevel information security and assurance systems

Develop technologies that enable the integration of unclassified and classified systems for joint and coalition operations. Provide authentication, encryption, and information assurance/integrity services in conditions typical to Marine Corps distributed operations: intermittent connectivity, limited throughput in restricted and hostile environments.

-- C2 STO-3: Intelligent network monitoring, maintenance, and mobility for on-demand information distribution

Develop intelligent network management technologies to enable the maintenance and distribution of large data files across the future battlespace to include network management/mobility tools and relaying capabilities that enhance the ability of the MAGTF to conduct OTH/OTM C2 capabilities in an expeditionary environment.

-- C2 STO-4: Improved situational awareness for warfighters at all echelons

Develop appropriate cognitive technologies, intelligent agent technologies, and other relevant technologies to enable Marines -- across all echelons and elements of the MAGTF -- to effectively utilize the future network of digital information, including tailored services to the appropriate tactical echelon. Enable sharing of appropriate situation awareness, and tailor information with high levels of automation, across all MAGTF echelons in near-real time with

cognitive objectives being high levels of automation. Specifically, enable near-real time distribution of tailored information across all echelons of the MAGTF.

Maneuver

The S&T investment in maneuver is the following areas: (1) increasing the air-mobility of vehicles either through making them internally aircraft transportable or through development of a means to transport them externally from aircraft at high speeds, (2) survivable and fuel-efficient family of vehicles, (3) more survivable aviation connectors and ability to protect and insert capabilities at greater distances in reduced times[6], and (4) improved mobility for the dismounted Marine.

***The Vision*: Marines will maneuver from the seabase in a family of high-speed connectors that include amphibious vehicles, tilt-rotor and rotary bladed aircraft, and high-speed surface craft. Once ashore, Marines will maneuver utilizing a family of highly mobile and survivable combat vehicles.**

Goal: The focus is to achieve needed operational and tactical mobility in support of EMW. This includes projecting forces from the seabase, and once ashore, employing vehicles that are significantly more sustainable through Autonomic Logistics and survivable with alternative power systems, a reduced requirement for fuel, along with crew and manpower reductions. Mobility systems will be more reliable with a reduced requirement for routine maintenance and employ autonomic features to integrate functions of crew, vehicle, and weapon system. Dismounted Marines will employ technologies that enhance their performance: in speed, range, and in load bearing capacity.

-- MVR STO-1: Advanced power plants, drive trains, and suspensions

Develop technologies to support a new family of vehicles that are lighter in weight and thus more fuel efficient and capable of being more effectively transported by air from the seabase ashore. Advanced propulsion, drive trains, and suspensions to improve performance over rough terrain are required to enable greater agility enhanced by speed and mobility.

-- MVR STO-2: Advanced and composite materials to enhance the performance and survivability of combat vehicles

Develop technologies to improve the survivability of both current and future tactical and combat vehicles through the use of innovative passive and active technologies.

-- MVR STO-3: Augmented cognition for combat vehicle crews and operators of maneuver systems

Develop technologies to assess cognitive state and workload of human operators non-invasively and to manage workload of the combat vehicle crew, the vehicle weapon system, and the vehicle IT infrastructure to improve man/machine performance in moving, shooting, and communicating.

-- MVR STO-4: Aviation technologies that increase the capacity of aviation assets

Develop technologies for rotary wing and heavy-lift applications to increase survivability and decrease the weight of aircraft in order to increase performance of rotary wing transport aircraft. Development of unmanned alternatives to manned helicopters for the delivery of logistics support with reduced risk to manned aircraft is also desired.

-- MVR STO-5: Dismounted Marine performance enhancements

Develop technologies, such as exo-skeletons[7] that will enhance the performance of the Marine by improving load carrying capacity and speed and distance of movement.

-- MVR STO-6: Advanced robotic systems for ground combat

Develop technologies for robotics, teleoperation, autonomous operation, machine vision, and related means for taking the human out of direct involvement in hazardous and exceptionally arduous missions.

Logistics

The S&T investment in logistics is primarily focused on four areas: (1) logistics tracking and enroute visibility, (2) packaging, (3) reduction in battlefield consumption of major consumables, and (4) dense power generation and storage.

The Vision: ***Marines of the future, operating as distributed forces and supported from the seabase, will demand a tailored level of sustainment that must be transported from the seabase and then accompany the force ashore. Logistics systems of the future will be more effective, more flexible, and provide better support.***

Goal: The focus is to provide support from a seabase to the operational echelons ashore down to the tactical level of operations adaptive to the needs of dispersed and highly mobile forces. The inventory of theater-wide sustainment will be continuously updated to support a dynamic distribution system empowered by automated logistics decision support system. Logistics will be provided to the warfighter as needed from the seabase by leveraging theater stocks, tracking and shifting assets even while en route, delivering tailored logistics sustainment packages with minimum development of rear areas, and dumps and marshalling areas ashore.

-- Log STO-1: Total asset visibility technologies for seabased logistics operations
Develop technologies that support identification/tagging solutions in order to provide source data to allow for a more efficient and robust Enterprise View/Management of the Logistics chain. Ensure that the developed technologies that support Combat Service Support Element operations are able to meet the restrictions of Radiation Hazards i.e. (HERO, HERP, and HERF).

-- Log STO-2: Predictive maintenance systems

Develop technologies that allow for a comprehensive prognostic/diagnostic and networked maintenance information system that leverages autonomic logistics capabilities embedded in new vehicles and supports legacy vehicles to provide for predictive maintenance before breakdowns.[8]

-- Log STO-3: Advanced expeditionary packaging and delivery

Develop packaging technologies that both reduce the cube and square of sustainment and facilitate unit distribution from the seabase to the individual user or weapons system. Develop composite, collapsible intermodal packaging for use within the twenty-foot equivalent units.

-- Log STO-4: Water purification and water-making capabilities

Develop technologies for water purification and for the production of water from air and vehicle exhaust. In addition, develop the concept and technology for a new system of seabased water packaging and delivery systems.

-- Log STO-5: Alternative power sources

Develop ways to reduce the Marine Corps dependency on fossil fuels with new technologies that support warfighting and at the same time reduce the MAGTF's footprint ashore.[9] Improve power management, generation, and storage technologies, replacing current batteries with alternatives that are cheaper, environmentally friendly, more compact, and with a longer service life such as fuel cells, micro-turbines for tactical generators, and other relevant technologies.

Fires

The S&T investment in fires is focused in five areas: (1) target detection, (2) advanced weapons systems, (3) munitions and fuses, (4) less lethal fires alternatives, and (5) the development of directed-energy weapons.[10]

The Vision: ***Marines of the future will be focused on seamlessly applying Naval and Joint fires using a universal spotter concept enabled by the shared situational awareness afforded by the netted battlespace. They will also have an enhanced capability to apply scalable lethal and non-lethal effects with great precision, resulting in less collateral damage and less fratricide.***

Goal: The focus is to streamline the fires process network and the network-wide sharing of position location information to enable improved target detection, location, and clearance. Weapons systems will be reduced in weigh and size, and capable of mobility equal to that of the force they are designed to support. Responsiveness will be enhanced by greater reliance on loitering munitions. Fires will be increasingly discriminate through precise target location, highly accurate weapons, all weather standoff, and scalable weapons effects. Concurrently, multispectral sensing, automated target recognition, and other advances will enhance the detectability of targets throughout the battlespace, improving detection ranges, turning night into day, reducing fratricide and accelerating the tempo of operations. A range of weapons effects will be available to the commander from electronic attack against systems, to kinetic weapons against personnel, vehicles, and facilities, to scalable weapons effects through multiple

means including directed energy. Expeditionary forces will employ weapons that are designed to reduce the logistical demands and take maximum advantage of seabased logistics support systems.[11] *The ability to produce a broad range of weapon effects, from non-lethal to hard-target kill, from sensor-fused to directed-energy weapons will enhance our capability.*[12]

-- Fires STO-1: Fires detection and engagement systems against incoming direct and indirect fires

Develop technologies that enable near-real time detection of incoming fires and position location of the source to facilitate engagement. Technologies that detect incoming rockets, mortars, artillery, and direct fire weapons – specifically snipers in urban terrain – are desired.

-- Fires STO-2: Lightweight, all weather, precision targeting technologies

Develop technologies that enable mounted and dismounted maneuvering forces to locate, discriminate, and provide target location information in order to facilitate immediate target engagement by either direct or indirect fires. Technologies are specifically needed for dismounted forces to use at night and in adverse weather conditions at extended ranges. Technologies that enable dismounted forces to designate targets with easily manpackable systems are also desired.

-- Fires STO-3: Highly responsive loitering munitions

Develop technologies that permit on-call immediately responsive fire support to the warfighter in support of either ground or aviation borne maneuver through loitering or persistently available munitions.[13] The munitions may be independently deployed and individually targeted or multiple-deployed aboard a UAV with individually targetable munitions. The munitions must be capable of being individually targeted by forces on the ground, in the air during aviation-borne maneuver, or by airborne forward air controllers.

-- Fires STO-4: Pulsed and continuous wave High Energy Laser (HEL) weapons

Develop technologies that generate optical, infrared, and other appropriate wavelengths of coherent energy. Focus is high-energy laser technologies, as well as explosively driven isotropic radiators and other appropriate technologies that can produce both high average and high peak power. HEL sources should be made frequency agile whenever possible and should strive for compactness, energy efficiency, and effective thermal management.[14]

-- Fires STO-5: Low-cost scaleable, modular, and enhanced-effects munitions

Develop technologies that enable design of munitions that closely match terminal effects to the target. The emphasis is to affordably decrease the circular error probable (CEP) while tailoring the effective casualty radius (ECR) in order to enhance effects on target and decrease collateral damage.

-- Fires STO-6: Pulsed and continuous wave, low energy, coherent and incoherent light, and acoustic weapons for non-lethal applications.

Develop technologies that utilize various acoustic techniques and optical frequencies for degrading enemy personnel effectiveness, ISR and targeting capabilities at various power and repetition rates, and with coherent as well as incoherent light sources.

-- Fires STO-7: Directed energy for non-lethal applications and lethal applications[15]

Develop technologies that provide a less lethal alternative to kinetic/blast weapons for employment in urban operations to clear facilities, disrupt crowds, and reduce the risk to ground forces involved in urban clearing.[16] In addition, develop technologies that enable scalable directed-energy effects[17] that can provide weapon systems that can deliver non-lethal or lethal effects (scaleable from lethal to less than lethal).[18] Develop directed energy technologies that generate terahertz, millimeter, and microwave electromagnetic radiation at high average and/or peak power. RF sources should be made frequency agile and should strive for compactness, energy efficiency, and effective thermal management. Both technology development and bio-effects research are required concurrently.

-- Fires STO-8: Automated fire control for infantry weapons

Develop for use with infantry weapons, technologies that provide ranging, target location, ballistic compensation and target data handoff.

-- Fires STO-9: Advanced gun and propulsion technologies

Develop technologies, e.g., electric magnetic, electric thermal etc…[19] that will increase capabilities of direct and indirect fire weapons (small arms through major caliber). These will enhance weapon performance and decrease weight, as well as logistics loads.

-- Fires STO-10: Lightweight Optics

Develop for use on infantry weapons technologies for durable, lightweight optics (including single integrated day/night scopes) that are quiet, easy to use, and operable in all environments. Technologies would provide low-power generation requirements, day-night use, and possess target detection and discrimination capabilities.

Intelligence

The S&T investment in intelligence also includes surveillance and reconnaissance constituting a complete ISR capability set which is focused on three specific areas: (1) intelligence collection, (2) signal exploitation technologies, and (3) intelligence analysis, fusion, and dissemination. In addition, there is a requirement for technologies to deny selective spectra from the enemy.

<u>The Vision</u>: Commanders at all levels have both the capability to leverage the Joint intelligence, surveillance, and reconnaissance architecture and to conduct reconnaissance, surveillance, and target acquisition functions commensurate with their mission with assets that they control.[20]

Goal. The focus is data collection, intelligence fusion into usable products, and distribution of relevant information across the network to all authorized users. Using the network, relevant intelligence is available in near-real time to all authorized users globally. In addition, to "top-down intelligence," commanders at all levels require the collection tools to actively conduct reconnaissance, surveillance, and target acquisition in areas that support their own assigned missions. The results of this "bottom-up" tactical intelligence collection is then entered into the network and adds granularity to the shared situational awareness available to decision makers at all echelons of command via the shared data that underpins the common relevant tactical picture. Recent world events and analysis of likely futures have resulted in focusing efforts on urban and asymmetric warfare capabilities as well as Distributed Operations.

-- Intel STO-1: Tailored tactical sensor fields

Develop tools and sensors that can translate a Commander's intelligence requirements into tailored sensor fields. Characteristics of these sensor and sensor fields include: (1) low cost since persistent surveillance equates to large numbers of sensors, (2) organically controlled and capable of providing situational awareness data to agile small force packages, and (3) deployable to areas we do not control.

-- Intel STO-2: Mobile tactical unattended collection sensor platforms

Develop platforms for mobile, distributed unmanned – autonomous and semi-autonomous – collection platforms to support the reconnaissance, surveillance, and target acquisition needs of commanders at all echelons of command. Supporting technologies that reduce the cost of collection platforms and reduce the training required for their support and employment.

-- Intel STO-3: Scalable multi-spectral sensor networks

Develop technologies that enable self-forming, hyper-spectral, multi-modal sensor networks, which can be used for wide area surveillance and to provide cuing and target discrimination in complex terrain.

-- Intel STO-4: Family of improved sensors

Develop improved hyper-spectral sensor payloads that provide greater granularity, discrimination, and at reduced size, cost, and power requirements that can be used in unmanned mobile and fixed sensor networks. Technologies that reduce the size of sensors, power sources, communications devices, and support employment over extended periods of time contribute can to this capability.

-- Intel STO-5: Algorithms capable of translating data to information at the point of collection

Develop mature algorithms that can translate raw Imagery Intelligence, Signals Intelligence, Measurement and Signature Intelligence, and Human Intelligence data to useful information at the point of collection in order to conserve bandwidth. Develop agents that can maintain overall sensor field situational awareness and provide individual sensor nodes with context needed to optimize the translation of raw data to useful information.

-- Intel STO-6: Sensor technologies for persistent ISR through unmanned aerial platform sensor technologies

Develop sensor technologies that are specifically applicable to unmanned aerial systems that can be either lighter-than-air[21] or air-breathing UAVs.

-- Intel STO-7: Comprehensive all-source data fusion and distribution

Develop technologies that fuse the results of multi-source persistent surveillance through a federation of tactical data bases, permit the movement of intelligence across multiple levels of security, and enable the distribution of actionable intelligence data across the network in near real time.

-- Intel STO-8: Communications and network denial

Develop technologies that enable the denial of selective communications spectra to the enemy. Denial can be through jamming or through the insertion of deceptive or misleading data. In addition, develop technologies that counter attempts to deny our use of the RF spectrum for communications and network operations.

Force Protection

The S&T investment in Force Protection is focused in three areas: (1) individual protection, (2) platform protection, and (3) autonomous systems. The investment in individual and platform protection is intended to provide increased survivability across the spectrum of conflict. Force protection technologies are needed to reduce the weight while increasing the levels of protection of armor for individuals and platforms (vehicles as well as aircraft). In addition, technologies are needed that can protect individuals in chemical, biological, and radiological environments with increased mission effectiveness. This focus on the individual and platform protection should not be construed as negating interest in protecting the MAGTF as a whole from a variety of network attacks and kinetic attacks either ashore or afloat. Rather limiting the discussion to individual and platform protection issues, acknowledges the larger investment in joint and naval protection systems. The inclusion of autonomous systems under force protection recognizes that one major advantage of autonomous systems is the performance of dangerous, dirty, and distant activities formerly performed by Marines.

<u>The Vision</u>: Future protection for the Marine and the Force will rely on various technological protective systems countering the most likely threats.

<u>Goal</u>: The focus is on individual Marine's equipment, platforms and vehicles, and autonomous systems. Marines are equipped with protective clothing and equipment that reduces the individual's optical and heat signature, and improves survivability against the most common threats while minimizing impact on mission accomplishment. Vehicles and platforms are designed to minimize the effects of blast – specifically from mines detonating in the vicinity of wheel wells – and with the capability to readily adapt to threat-specific armor additions as needed. Active defense systems counter the most common threats to vehicles and platforms. Autonomous systems provide tools that reduce the risk to Marines conducting specific tasks to include but not limited to reconnaissance, local security, mine clearing, and EOD.

-- FP STO-1: Technology that provides improved protection for the individual against fragments, projectiles, and lasers with reduced weight and impact on ability to perform required functions

Develop technologies that improve the helmet, body armor, and eye protection for the combat Marine against a variety of threats improving comfort and ease of employment while performing combat functions such as using the service weapon in a prone position or with the gas mask. Eye protection – to include optics – is needed to counter the emerging threat of multi-spectral battlefield lasers.

-- FP STO-2: Technologies for improved protection for individuals and vehicles in a chemical, radiological, and biological environment

Develop full body suits and collective protection systems, as well as threat detection and warning systems that provide increased protection[22] while reducing the limitation that environmental factors such as heat, have on mission accomplishment. In addition, develop technologies that enable decontamination with reduced – or ideally without – the requirement for water.

-- FP STO-3: Incorporation of improved materials for future vehicles and aircraft that provide improved levels of protection at reduced weight and volume

Develop technologies that have better blast and ballistic protection qualities while reducing the overall weight to the vehicle or platform in order to decrease the impact on performance. Where applicable develop technologies that enable threat-specific protection to be readily added to vehicles and platforms as needed for a specific mission or to counter an emerging threat.

-- FP STO-4: Active protection system for vehicles against rocket propelled grenades.

Develop technologies that provide active protection but without unacceptable threat to supporting dismounted forces or non-combatants in the proximity of the vehicle.

-- FP STO-5: Autonomous systems

Develop a full suite of unmanned aerial and ground autonomous systems tailored to support missions that would otherwise put Marines at risk. Specific requirements exist for mobile sensors, loitering munitions, and systems to detect and neutralize specific threats such as Improvised Explosive Devices (IEDs) and mines. Mission payloads and secure communications links are specifically required.

Mine Countermeasures

The S&T investment in Mine Countermeasures is intended to enable unrestricted maneuver across the littoral battlespace and therefore is a naval problem requiring a variety of technologies and warfare area coordination in order to provide a comprehensive capability at sea, in the surf zone, over the beach, and ashore to the maneuvering forces.[23] IEDs pose a different, but related threat with many of the same requirements as mines. The Marine Corps mine countermeasures S&T investment is focused in three specific areas: (1) detection, (2) neutralization, and (3) investigative technologies to track mines/IEDs to their source.

The Vision: ***Marines maneuvering from the seabase will be able to conduct assault breaching of complex obstacles (including minefields) and follow assigned tracks through the shallow water, the surf zone, over the beach, and inland without impeding maneuver.***

Goal: ***The maneuvering forces will have the ability to detect and neutralize mines and IEDs from a distance that does not put the maneuvering force at risk and with minimal impact to rate of advance. Once established ashore, MAGTF elements will have the ability to continue to detect, avoid, and neutralize mines in complex terrain including urban environments. Where mines and/or IEDs are detected, the MAGTF commander will have the ability to rapidly apply investigative methodologies to determine source of devices.***

-- MCM STO-1: Mine detection from the surf zone to the high-water mark and inland

Develop the technologies to enable the detection of mines and minefields from the surf zone through to inland objectives[24] for sustained operations ashore. Detection technologies must encompass a variety of threats including surface laid and fully buried mines as well as both near-field/far-field detection and include multi-spectral approaches with particular emphasis on detecting low-metallic and non-metallic mines.

-- MCM STO-2: IED detection technology

Develop technologies enabling the detection of IEDs from a distance. Detection technologies that address the entire IED kill chain (to include the recruitment of bombers and acquisition of IED components at one end and the identification of the detonators on deployed mines at the other end).

-- MCM STO-3: Mine and IED neutralization

Develop technologies to either neutralize mines and IED's from a safe distance or induce a pre-detonation/deflagration in order to remove the threat from maneuvering forces. These

technologies include active and passive countermeasures to devices, energetic neutralization methods to kill devices, and mechanical methods to rapidly clear devices.[25]

-- MCM STO-4: Investigative technologies and methodologies

Develop the technology to permit the operating forces to perform and apply investigative techniques on explosive devices in order to determine patterns and to track back IEDs to their source.

Human Performance Training and Education

The S&T investment in Human Performance Training and Education is intended to empower the future Marine by closing human performance gaps using training and education as well as physiological and nutritional solutions. Equally important is the development of tools to prepare Marines – from fire teams through the MAGTF level – in order to exploit the emerging simulation and collaborative training environments that permit integration of live, virtual, and simulated training.

***The Vision*: To create tomorrow's intellectually superior, expertly trained, mentally and physically prepared Marine. Marines at every level will have access to a family of computer-based digital training simulation tools to support their individual and unit training objectives, as well as to assist in crisis decision making at all levels and to prepare them for the environmental rigors of the future battlefield.** [26]

Goal: The intent is to develop a family of training and decision tools that employs an open architecture, is adaptable to training tasks involving naval and joint forces, can be deployable and seamlessly operated aboard ships,[27] *ashore, over naval networks, and can be readily adapted to new missions and training scenario needs. It must be a system of systems that is capable of hosting a variety of existing individual training applications as well as educational interaction multimedia instruction, yet can be flexibly adapted to rapidly advancing simulation and game technology advancements. At the individual level, Marines of all grades should be able to practice decision making in simulations appropriate to their grade.*[28] *At the unit level, Marine commanders should be able to exercise their staffs and subordinate elements transparently using their warfighting systems in a netted simulation that is scalable from the squad to the Joint Task Force level. Simulations will approximate wartime conditions to provide realistic and stressful training resulting in a high state of combat readiness.*

-- HPT&E STO-1: Cognitive Performance Enhancement Methodologies and Technologies

Develop tools to support real-time cognitive and behavioral assessment and improvement of Marines and teams during operations and training. Develop training systems and novel training principles that accelerate and enhance the training progression of both the individual Marine and teams of Marines working in Distributed Operations environments. Implicit is the need to develop systems that will enable the Marine Corps to more effectively screen individual Marines based on their decision-making ability or their capability for mastery of decision-making skills. Technologies are needed to demonstrate novel brain/machine symbiosis to infer and/or augment

human cognition and performance, improve capacity for responding to asymmetric situations, develop intuitive decision-making, develop dominant speed of pattern recognition, and enhance the intellectual capacity of Marines to conduct maneuver warfare.[29]

-- HPT&E STO-2: Synthetic Environment Technologies

Develop training systems to enable Marines and units to train the way they fight and provide greater situational awareness for after action review of live fire and force-on-force training evolutions. Of special interest is the capability to enhance situational awareness capability for small units - specifically those conducting Close Quarter Battle (CQB) and operations in complex terrain (urban operations). This will support improved mission planning and rehearsal aboard ships and in remote training sites without access to training facilities.

Develop technology to rapidly create three-dimensional models of the interiors and exteriors of buildings in any MOUT environment. Develop technology to view the training event from any viewpoint using the three-dimensional model, and identify and track trainee's performance throughout the training environment. Training performance information will be automatically recorded and evaluated proving precise adjudication of training events, situational awareness and lessons learned during subsequent playback and after tactical review. Of particular interest is the development of constructive simulation wrap-around for urban exercises.[30]

-- HPT&S STO-3: Training Technology Enhancement Tools and Technologies

Develop instructional/training tools, technologies, and systems to enable Marines to train the way they fight and provide greater situational awareness for after action review of live fire and force on force training evolutions. Develop low cost, deployable training technologies that can be effectively operated on organic computers and local area networks to provide realistic, tactical decision-making scenario based training for individual Marines, small units, and staffs throughout the MAGTF.

-- HPT&E STO-4: Physical Performance Enhancement Methodologies and Technologies

Develop a knowledge base that links human physiology, psychology, and neural science in order to prepare the Marines of the future for a battlefield. The aim is to develop strategies for mitigating the adverse effects of sleep deprivation, fatigue, extreme heat and cold, high altitude, ergonomic load, information overload, emotional stressors, and other factors in order to enable future Marines to perform at a level of order of magnitude higher than today.

Annex A
N6/7 Warfighting Gaps

SEA SHIELD

LASW Gap 1: **Rapid Submarine Cueing, Detection, Localization, and Neutralization in Shallow and Deep Water**

Provide improved submarine cueing/wide area search and wide area classification rates in shallow and deep water, including cluttered littorals and areas with poor acoustic conditions, including the ability to transition rapidly from localization to submarine neutralization/engagement.

LASW Gap 2: Platform Defense against Undersea Threats, Including Ship Self-Defense Against Multi-Salvo Torpedo Attacks

Provide a capability to prevent any of the torpedoes in up to four-torpedo salvos fired at high value units from hitting the units.

OMCM Gap 1: Capacity to Clear Large Areas of Mines without Cued ISR

Provide capability to counter large areas of sea mines without cued ISR, which should reduce the current MCM timeline for detecting, classifying, identifying, and clearing moored and ground mines in shallow-to-deep water.

OMCM Gap 2: **Destruction of Mines in Areas through which Marine Corps and Joint Forces Must Maneuver, Ranging from Deep Water through Surf and Beach Zones**

Provide the destruction of mines and/or obstacles to allow Marine Corps and/or Joint Forces to safely maneuver from deep water through the surf and beach zones. Capabilities must include Intelligence, Surveillance, and Reconnaissance/Intelligent Preparation of the Battlespace (ISR/IPB), in addition to engagement capabilities.

FFP Gap 2: Adequate Detection and Engagement of Terrorist and Special Operations Force Threats to Ships in Port and Transiting Restricted Maneuverable Choke Points

Provide detection and engagement of terrorist and special operations force threats (undersea, surface, and air) to ships in port and transiting restricted waters. Provide the capability to determine the intent of potential threats, and deter them using non-lethal technologies when actual intent remains undetermined.

FFP Gap 3: Counter Coordinated Small Boats

Provide a capability to counter coordinated small boats. Capability should include not only the ability to detect and identify small boat threats, but also to counter the small boat threat with lethal and non-lethal means.

MD Gap 1: Sea Based Missile Defense of Ships and Littoral Installations

SEA STRIKE

USMC & N3/5 Gap 1: Urban Asymmetrical & Expeditionary Operations

Marine Air-Ground Task Force Operations in Support of Asymmetric Warfare in the Urban and Dispersed Battlespace will allow tactical elements of a Naval Expeditionary Force (NEF) to operate more effectively across the spectrum of all six warfighting functions in unconventional environments as well as complementing and enhancing the NEFs ability to successfully prosecute missions in a more traditional scenario. Thus the intent of this Gap is to enable NEF elements to gain, maintain, and exercise freedom of action aided by technological solutions encompassing (a) situational awareness tools; (b) enhanced tactical maneuver support; (c) advanced mobility and survivability; and (d) land mine/Improvised Explosive Devices counter measures. N3/5: This Gap will facilitate threat detection, ensure situational awareness, and enable lethal and non-lethal responses to win engagements and prevent damage to critical infrastructure due to asymmetric attack from land, sea, and air.

TCS Gap 2: Survivability of Aircraft Operating at Low Altitudes

Provide systems for low flying aircraft, including rotary wing aircraft that provide countermeasures to MANPADS, missiles, and other low altitude threats.

TCS Gap 3: Persistent High Speed Strike Weapon to Engage Time Critical Targets

Provide an affordable ship and sub launched, inexpensive, high-speed weapon with short time of flight to successfully effect likely long-range engagements. Weapon should use flexible weapon effects (e.g., blast/fragmentation and/or sub munitions).

TCS Gap 4: Weapons with Standoff and Fire-and-Forget Capability Against Moving Targets

Provide the capability to engage and defeat multiple moving targets operating in close proximity to noncombatants regardless of weather or environmental conditions. Provide an affordable weapon system(s) to engage moving land and sea surface targets up to and including light armored vehicles. Must have sufficient standoff range outside threat engagement zones. Accuracy/lethality consistent with target set destruction/mobility kill. Capability needed for autonomous terminal guidance to target. Need capability for near real time damage/hit assessment of >85% to minimize restrike operations.

LCPP Gap 2: Naval Fires to Support Speed/Depth of Marine Corps and Joint Maneuver

Provide Naval Fires capabilities to support speed/depth of Marine Corps and Joint Maneuver. Capabilities should include low cost mid-course guidance & propulsion for gun launched weapons, real time deconfliction of extended range naval surface gunfire, and air support assets to prevent blue on blue engagement.

SEA BASE

EXLOG Gap 1: Sea Base Mobility

Enable operational maneuver from the sea through rapid force closure and maintain mobility while conducting at sea arrival and assembly. Force closure objective of 10 days and threshold of 14 days. All transfer capabilities to be achievable with an objective through sea state 5 and a threshold through sea state 4. Connectivity for arrival and assembly operations is to be achieved with an objective of 24 hours and a threshold of 72 hours.

EXLOG Gap 2: Sea Base Persistent Combat Operations

Maximize the effective throughput within and from the sea base to ashore combat operations with a tailored force response, by integrating operational, maintenance, and logistic planning and distribution systems, thereby reducing or eliminating the operational pause and enabling persistent combat operations.

FORCENET

KSA Gap 1: Joint Combat ID

Blue force tracking capability is needed to automate, merge, and display the full range of Blue, Coalition, and Allied Forces (Ground, Aircraft, Surface, Subsurface) for planners and shooters, including improved recognition rates for non-cooperative targets. Joint real-time automated tracking system to support a multi-level security accessible blue, white, red, and coalition picture (ground, air, surface).

KSA Gap 2: Optimal Mix of Naval Sensors to Complement Joint and National Capabilities to Meet Naval Mission Requirements

Provide an optimal mix of sensors to complement joint and national capabilities to meet naval mission requirements. Capabilities should include organic reconnaissance platforms that can penetrate denied areas and provide real-time reporting to tactical units and persistent, low-cost, unattended, and networked remote sensing devices.

KSA Gap 3: Computer Network Defense and Information Assurance

Enable computer network defense and information assurance in areas that include cryptographic protection, layered network defense and intrusion detection, IA/CND situation awareness capability, and local workstation defenses.

- Automated multi-level security to Naval C4ISR architecture including appropriate computer network defense measures.
- Scalable, flexible, deployable, user-friendly cross-domain network security in a HAIPE "black core" environment.

KSA Gap 4: Ubiquitous, Secure Communications and Network Infrastructure

Provide a ubiquitous, broad-scoped secure communications and network infrastructure that includes the major architecture component for transmitting and receiving high data rate voice and video aboard surface ships and tactical aircraft secure from a single aperture.

Communication with unmanned vehicles, and manned platforms is also required. In addition, a cost effective, preferably non-aviation alternative to TACAMO is needed.

- High bandwidth technologies to support Naval connectivity to the Global Information Grid.

- Beyond Line-of-Sight, Over-the-Horizon (BLOS/OTH) network connectivity to tactical users On-the-Move (OTM).

KSA Gap 5: Link Management and Architecture

Provide capabilities including assurance of seamless interoperability, automated language, target recognition, targeting (bombs on target), and imagery analysis.

KSA Gap 6: Common and Persistent Maritime Picture on/below the Surface

Provide a common and persistent maritime picture on/below the surface. Capabilities should include ability to network multi-spectral sensors and INTEL data into a local area COTP, integrate independently compiled local area COTPs into a mission-oriented COTP, provide interoperability to accept coalition inputs and provide COTP products to coalition forces, and provide COTP access to all users.

- Automation of sensor and intelligence information inferencing and fusion support tools to provide Blue, White, Red and Coalition Forces picture driven by national and tactical sensors from the strategic to the tactical level for use in a mobile, ad-hoc environment."

- Near real-time information system that provides the decision maker the ability to depict all relevant situational information in a user-defined, situation tailorable, shareable, and primarily visual medium."

KSA Gap 7: Persistent ISRT for Accurate Target Discrimination and Location

Provide persistent ISRT for accurate target discrimination and location. Capability should include survivable ultra-long endurance ISRT--Space, Air, or Ground Based--operating in any battlefield environment. Additionally, capability should also include tools for battle damage assessment for standoff weapons using existing/planned sensors, leveraging national sensors if appropriate.

- Netted, persistent, all-weather, day/night capability to detect, locate, identify and track hostile, neutral and friendly mobile and maneuvering units.

- Netted all-weather day/night near real time detection of obstacles, mines and IEDs in all ground and water environments, including pre-employment activity.

<u>Enterprise & Platform Enablers</u>

ACES Gap 1: Advanced Pulsed Power

Demonstrate key technologies to enable large pulsed-power offensive and defensive systems on future combatants.

ACES Gap 2: Battlefield Power

Demonstrate advanced battlefield power generation technologies to reduce the logistic footprint and keep pace with increasing power demands.

TOC Gap 1: Turbine Engine: Reduce cost of operations.

Develop: innovative materials and processes for more fuel efficient, lighter turbine engines.

TOC Gap 2: Reduce Support Costs

Develop material science solutions for: 1) low maintenance materials, 2) corrosion control and prevention. Develop prognostics technologies for: 1) condition based maintenance, 2) failure prediction and prevention, 3) mission life prediction.

Annex B
Future Naval Capabilities

1. The Future Naval Capabilities (FNC) is a process to align and partner S&T with the requirements and acquisition communities in the delivery of new near-term (FYDP) capabilities to the Fleet/Force. Emphasis is placed on high priority capability requirements and funding is coupled with acquisition funding to ensure more rapid transition to acquisition and deployment to Naval forces. There are five FNCs aligned with the Sea Power Pillars:

a. Sea Shield
b. Sea Strike
c. Sea Basing
d. FORCEnet
e. Enterprise & Platform Enablers

2. FNC Integrated Program Teams (IPT) perform management of assigned S&T FNC Enabling Capabilities (ECs) from S&T into acquisition programs. Management responsibility includes technology transition planning, development of CONOPs, supporting ONR in the development of EC proposals and periodic assessment of the development of the ECs and the systems that will integrate the EC products. The FNC IPTs have execution oversight of assigned ECs and may propose gaps for consideration by the Technology Oversight Group (TOG) for S&T development.

3. Marine Corps relevant ECs and associated products span the Pillar IPTs. However, the majority falls within the Sea Strike FNC and the Urban/Asymmetric Expeditionary Operations EC. Expeditionary Warfare and Combating Terrorism Department (Code 30) has cognizance for the Marine Corps Gap/ECs.

Annex C
Aviation Science & Technology Objectives

1. Aviation S&T Strategic Guidance. These are Aviation focal points in terms of (a) S&T Program Opportunities and (b) Legacy S&T Investment Category Priorities. This Annex serves to articulate Marine Corps unique S&T needs to those agencies devoted to Aviation S&T priorities.

a. Key Program Challenges. These are the major Aviation program areas that have opportunity for high-payoff S&T investments:

(1) Heavy Lift Replacement (HLR)
(2) Airborne Electronic Attack (AEA) follow-on
(3) Tiltrotor UAV

b. Legacy (rotorcraft) Investment Category Priorities. These are prioritized categories in terms of current rotorcraft force S&T technology modernization/transition/insertion as well as future rotorcraft programs. These areas directly correspond to Marine Corps priorities to the US Army S&T Strategic Planning document and are emphasized due to a historical minimal investment in rotorcraft S&T.

(1) Affordability

- Reduction in Development, Acquisition, Operating and Support Cost While Maintaining or Increasing Capability.

(2) Supportability/Maintainability

- Improvement in Reliability, Availability and Maintainability.

(3) Footprint

- Reduction in the weight and volume of the personnel, materiel, equipment and supplies that support an aerial system and must be moved.

(4) Survivability/Safety

- Improvement in the ability to avoid detection, tracking and engagement in a complex threat environment and survive hit/crash.

(5) Deployability

- Reduction in the time, effort, and support systems to prepare, transport, and restore a force capability.

(6) Battlefield situational awareness

- Improvement in the ability to know and comprehend the location, intent, and actions of blue/red forces, non-combatants, environment condition, terrain, and obstacles in the area of operational responsibility.

(7) Training

- The efficiency with which commanders/staff, pilots, operators and maintainers are initially and continuously trained to proficiency.

(8) Lethality

- Improvement in the ability to precisely deliver a spectrum of intended effects (lethal or non-lethal).

(9) Mobility

- The ability to responsively maneuver and transport troops, supplies and equipment on the battlefield in complex terrains/sea states.

(10) Battle Command

- Improvement in the ability of the commander to decide on a course of action and execute command measured in response time.

2. Aviation S&T Relationships. Relationships with the following agencies are essential in order for the Marine Corps S&T IPT to ensure visibility on adequate Aviation leverages, sharing unique leverage opportunities, and ensuring an overall balanced Marine Corps Aviation S&T investment.

a. ARMDEC. U.S. Army Research, Development and Engineering Command: responsible, by charter, for Rotorcraft S&T. This is a key relationship as Rotorcraft S&T investment has been minimal for over a decade.

b. Office of Naval Research. Achieved primarily via the Marine Corps S&T IPT, but also through a direct relationship with ONR.

c. Air Force Research Lab. In particular, the Technology Transition Office: a key S&T partner for development of a Marine Corps EW follow-on platform.

d. DARPA. In particular, ultra-wideband transmitter technologies for EA follow-on and advanced computing applications.

3. S&T in support of Aviation:

AVN STO 1: Standardized force tracking system

- Technologies that provide 100% assured, covert, real-time identification of friendly forces for fratricide avoidance as well as battlefield coordination, maneuver deconfliction, command SA, future resupply/CASEVAC etc during future distributed operations.

- Tracking technologies may be applicable for red-force/HVT (classified).

AVN STO 2: Advanced multi-function electronic warfare transceiver

- Leverage ONR NEXGEN jammer. Technologies must be compatible with Marine Corps follow-on EA platform (i.e. Low-observable) as the platform requirements are refined.

- Multi-function transceiver array potentially enables future Electronic Warfare as well as bandwidth, SIGINT and ISR

AVN STO 3: Advanced rotor/prop technologies for performance across wider envelope

- Rotor/Prop as a component of assault support propulsion as well as tactical UAVs will continue for the foreseeable future. As rotorcraft/helicopters (MV-22/VUAV) requirements grow in terms of hover load and harsh environments (heat), as well as top-end speed (i.e. MV-22 escort), advanced rotor performance enhancement (dynamic blade shaping) will garner performance as well as efficiency (fuel/load savings).

AVN STO 4: Variable-speed air refueling drogue

- Technologies that enable refueling drogues to refuel fast tactical aircraft as well as slower rotorcraft enable the entire aviation force.

AVN STO 5: Active kinetic and non-kinetic A/C self-protection

- Technologies such as High Energy Liquid Laser Area Defense System (to leverage the Advanced Tactical Laser ACTD for USMC benefit employing all-electric high energy laser technologies at DARPA) and continued investment in technologies which enabled systems such as Tactical Aircraft Directable Infrared Countermeasures: technologies must enable “unlimited magazine” self-protect capabilities against both IR SAMs and RPGs while reducing requirement for magazine (i.e. flares).

AVN STO 6: Sand and dust penetrating radar providing precision (landing quality) navigation video in brownout, dust-out visibility areas.

- Includes technologies that enable passive obstacle detection at range (i.e. uncharted wires/cables) and enable precision support of distributed operations in unprepared landing zones from future UAV tiltrotor, as well as possible technology transition into legacy rotorcraft.

AVN STO 7: Scalable, light weight, interference cancellation system for co-situated RF emitters to eliminate VHF and UHF RF interference between multiple radio systems

- Includes low-cost interference cancellation technologies for potential EA UAV as well as technology transition for legacy platforms that suffer communications degradation with multiple communications systems or jamming.
-

AVN STO 8: Cost effective Mass Memory (hundreds of gigabytes)

- Improvements for Digital Map and other avionics systems capable of higher speed data transfer, compatible with helicopter airborne environmental conditions.
- Enable autonomous operations with comprehensive information onboard. Information storage requirements onboard autonomous platforms reduce risk in distributed and net-centric operations against an EW-capable adversary where link information is potentially denied.

AVN STO 9: Helo-mode, low airspeed indication system

- Complementary technologies to precision quality navigation in brown-out/dust-out that enables precise, landing quality, non-visual air and groundspeed reference.

AVN STO 10: Multi-function, low-drag VHF, UHF, and UHF SATCOM antenna

- Enables reduced airframe antennae. Reduces airframe signature as communications requirements grow. Allows communications growth without additional apertures.

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